

The Essential Guide to Telecommunications

3rd Edition

Annabel Z. Dodd



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tiple “ramps” built by still more carriers [e.g., the incumbent local telephone companies, cable TV providers and competitive local exchange carriers (CLECs)].

AT&T constructed the “highway” system that is the basis of the public switched network in the United States. Prior to the 1984 divestiture, AT&T set standards via its research arm, Bell Laboratories (now part of Lucent Technologies), such that all central office switches and all lines that carried calls met prescribed standards. As a result of these standards, anyone with a telephone can talk to anyone else. Dialing, ringing, routing and telephone numbering are uniform.

The International Telecommunications Union (ITU) defines switching as “the establishment on demand, of an individual connection from a desired inlet to a desired outlet within a set of inlets and outlets for as long as is required for the transfer of information.” The inlets are the lines from customers to telephone company equipment. The outlet is the party called, the connection from the central office switch to the customer. A circuit or connection is established for as long as desired within the network until one party hangs up. Switched calls carry voice, data, video and graphics. They operate on landline and cellular networks.

The mobile or landline central office, which performs the switching function, routes calls based on the telephone number dialed. Carriers and resellers put their own brand names on their switched services. For example, AT&T sells OneRate, and Sprint offers Sprint 500 AnyTime.

Attributes of Real-Time Switching Services

The public switched telephone network (PSTN) provides real-time dial-up connections. Cellular, Internet dial-up and landline voice traffic is routed in real time based on digits dialed.

Addressing—The Ability to Reach Anyone on the Public Network

Telephone calls are routed to destinations based on the number dialed. This is the *addressing* function. Telephones on landline connections send dual tone multi-frequency (DTMF) tones over the network. At the central office, these tones or frequencies are decoded to address signals. In cellular networks, users first dial the number they wish to reach, and then press Send. The telephone number is sent as digital bits within packets to the mobile switching office.

In the North American Numbering Plan (NANP), which covers the United States, Canada and the Caribbean, three-digit area codes are assigned to metropolitan areas. *Exchanges*, the next three digits of a phone number, are assigned to a rate cen-

The Internet is a medium that has fundamentally changed the pace of business processes and the way organizations exchange information with each other. Businesses sell, place orders, receive orders, collaborate, train employees, provide customer service and bid for products over the Internet. Consumers commonly use the Internet to exchange electronic mail with family members, pay bills, conduct online stock transactions, calculate income tax returns, make travel reservations, shop and conduct research. They also spend time on the Internet playing games, listening to music and viewing entertainment.

The Internet is a connection of multiple networks. The networks communicate with each other over a suite of standardized protocols, Transmit Control Protocol/Internet Protocol (TCP/IP), in which data is broken up into "envelopes" called packets. For the most part, network operators use high-speed routers to transmit these packets. Internet traffic is sent at gigabit speeds. The high-speed lines are the backbone of the Internet. They carry the greatest amount of Internet traffic. The Internet backbone transmits requests for information, entertainment, audio and video broadcasts, email and business-to-business transactions. The different carriers that operate Internet backbone exchange traffic with each other at metropolitan area exchanges (MAEs) and network access points (NAPs).

The Web is a vehicle for multimedia presentation of information in the form of music, audio, video and text. The World Wide Web is not separate from the Internet. It is a way to navigate from resource to resource on the Internet by clicking on highlighted text or graphics from within browsers. As long as they use World Wide Web browsers, all PCs are compatible with the Web. Users point and click their way from computer to computer on the Internet. Before the World Wide Web was developed, documents on the Internet were available only as text. There were no pictures, no "buttons" to click on to issue commands and no advertising banners. There was also no color; everything was black and white.

Individuals and organizations connect their locations to the Internet via many types of telecommunications services including T-1, T-3, analog lines, digital subscriber line (DSL) services, integrated services digital network (ISDN) and cable TV facilities. Internet service providers (ISPs) aggregate traffic from many users and send it over high-speed lines to the Internet backbone. ISPs maintain routers and servers at their sites. The servers, powerful PCs that can be accessed by many users, perform various functions. They contain customer email, businesses' e-commerce applications and home pages for consumers as well as specialized content such as sports information and online games. Servers are located at hosting sites as well as ISP data centers. Hosting sites, where Web content such as corporate, ecommerce and entertainment sites are kept, have servers with information from, for example, search companies such as AltaVista and online retailers.

The popularity of the Web has made the creation and implementation of technologies that enable sites to handle spikes in traffic and large amounts of traffic impera-

tive. One of these techniques is caching, which spreads content among servers at the "edge" of the Internet, closer to end users. In addition to lowering traffic at each server, caching lowers the cost of bandwidth. It lowers the amount of distance packets travel to access Web pages.

Innovations also have occurred in search engine techniques and formatting email for marketing. Search engines are an important tool for organizing sources of online information. They have become faster and the results are more accurate. Corporations use them in their own Web pages to help employees, potential customers and trading partners find information on the corporate Web. Email is now used as a way to disseminate spam, marketing announcements and newsletters that look similar to Web pages. These email messages use the same method, Hypertext Markup Language (HTML), as used to apply formatting and insert graphics on Web sites.

Despite the technological improvements in the Internet, Internet companies are struggling to find profits. Scores of businesses that operated Web sites have gone out of business. Moreover, it has been generally agreed that advertising as a primary vehicle for underwriting the Internet is not viable. To date, gambling (which is illegal in most states), auctions, pornography, music and games are popular and often profitable on the Internet. While commercial organizations depend on the Internet for contact with customers and vendors, e-commerce where businesses exchange purchase orders and pay bills directly to one another's order entry and accounting systems are in their infancy.

Because the World Wide Web is new, legal, privacy and security questions are being raised that previously have not been addressed in this context. For example, freedom of speech for adults sometimes conflicts with protecting children from unsuitable online material. Online sharing of music and copyrighted articles may interfere with authors' and musicians' rights to earn royalties. In other instances, Microsoft's control of PC operating systems and browsers and AOL Time Warner's market share in instant messaging (IM) may give both companies unfair advantages on the Internet. All of these issues raise interesting questions about privacy, free enterprise and free speech.

World Wide Web technology is used by commercial organizations to create extranets and intranets. *Extranets* use Web technology to create platforms from which trading partners and customers can communicate. *Intranets* use the technology for internal portals and browser access to corporate data. The adoption of Internet technologies and protocols for internal use by commercial organizations represents a major impact of the Internet. It has led to faster, more convenient access by employees to corporate information.

THE HISTORY OF THE INTERNET

The Department of Defense's Advanced Research Projects Agency (DARPA) started the Internet in 1969, in a computer room at the University of California, Los Angeles. It wanted to enable scientists at multiple universities to share research information.

Advanced Research Projects Agency NETwork (ARPANET), the predecessor to the Internet, was created 12 years after Sputnik, during the Cold War. DARPA's original goal was to develop a network secure enough to withstand a nuclear attack.

The first communications switch that routed messages on the ARPANET was developed at Bolt Beranek and Newman (BBN) in Cambridge, Massachusetts. (BBN was bought by GTE. Bell Atlantic acquired GTE, changed its name to Verizon and spun off BBN as Genuity.) ARPANET's network used packet switching developed by Rand Corporation in 1962. Data was broken up into "envelopes" of information that contain addressing, error checking and user data. One advantage of packet switching is that packets from multiple computers can share the same circuit. A separate connection is not needed for each transmission. Moreover, in the case of an attack, if one computer goes down, data can be rerouted to other computers in the packet network. TCP/IP, the protocol still used on the Internet, was developed in 1974 by Vint Cerf and Robert Kahn. It supports a suite of services such as email, file transfer and logging onto remote computers.

In 1984, as more sites were added to ARPANET, the term Internet started to be used. The ARPANET was shut down in 1984, but the Internet was left intact. In 1987, oversight of the Internet was transferred from the Department of Defense to the National Science Foundation.

While still used largely by universities and technical organizations, applications on the Internet expanded from its original defense work. In particular, newsgroups used by computer hobbyists, college faculty and students, were formed around special interests such as cooking, specialized technology and lifestyles. The lifestyles newsgroups included sexual orientation (gay and lesbian), religion and gender issues. Computer-literate people were also using the Internet to log onto computers at distant universities for research and to send electronic mail.

The Internet was completely text prior to 1990. There were no graphics, pictures or color. All tasks were done without the point-and-click assistance of browsers, such as Netscape and Internet Explorer. Rather, people had to learn, for example, UNIX commands. UNIX is a computer operating system developed in 1972 by Bell Labs. UNIX commands include: m for Get Mail, j for Go to the Next Mail Message, d for Delete Mail and u for Undelete Mail. The Internet was not for the timid or for computer neophytes.

The advent of the World Wide Web in 1989 and browsers in 1993 completely changed the Internet. The World Wide Web is a graphics-based vehicle to link users to sources of information. It is based on a method whereby users "click" on graphics or text to be transferred to a site where information can be accessed. In 1993, the Mosaic browser was developed at the University of Illinois as a point-and-click way to access the World Wide Web. This opened up the Internet to users without computer skills. It is no longer necessary to learn arcane commands to open mail, to navigate from site to site for research or to join chat or newsgroups.